A REEVALUATION OF PHYSICAL PROTECTION STANDARDS FOR IRRADIATED HEU FUEL

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Presented at the 24th International Meeting on
Reduced Enrichment for Research and Test Reactors (RERTR)
Bariloche, Argentina

November 5, 2002

ABSTRACT

In the post-September 11 era, it is essential to reconsider all the assumptions upon which the physical protection systems of the past were based and determine whether these assumptions are still appropriate in light of the current terrorist threat.

For instance, the U.S. Nuclear Regulatory Commission definition of a "formula quantity" of special nuclear material is derived from the belief that a terrorist plot to carry out multiple coordinated attacks on different facilities with the goal of acquiring enough SNM for a nuclear weapon is incredible. This assumption has clearly been proven wrong by the September 11 attacks.

Another standard that needs to be revisited is the "self-protection" threshold that determines whether or not an item containing SNM is considered to be "irradiated" for physical protection purposes. The current value of this threshold, 1 Sv/hr unshielded at 1 meter, is of questionable value as a deterrent to determined terrorists who would be willing to sustain long-term injury as long as they could accomplish their near-term goals. A more credible threshold would be set at a level that would have a high likelihood of disabling the perpetrators before they could complete their mission.

Most irradiated nonpower reactor fuels would be unable to meet such a standard. This raises serious questions about the adequacy of the level of physical protection applied today to the large inventories of irradiated HEU fuels now scattered in storage sites around the world. The absence of a coherent global policy for dealing with these materials has created a situation rife with vulnerabilities that terrorists could exploit. The international community, now seized with concern about unused stockpiles of unirradiated HEU fuels around the world, also needs to appreciate the dangers posed by lightly irradiated spent fuels as well. A U.S. proposal to import Russian HEU for supplying U.S. nonpower reactors will only prolong this situation This paper will review policy options to mitigate this threat.

1. Introduction

In the United States, regulatory standards for the protection of special nuclear materials against theft have not been significantly revised since the early 1980s. At that time measures were adopted to conform to the international standards in IAEA's INFCIRC/225, *Recommendations for the Physical Protection of Nuclear Material*, which was published in 1975, several years earlier. Today, in the aftermath of the September 11 attacks on the World Trade Center and Pentagon, it is essential to assess the validity of the assumptions about the nature of the terrorist threat that were commonly held in the 1970s yet still underlie the current regulatory regime. Some examples of the mindset of the NRC at that time include the following:[3]

- "Since terrorist organizations not aligned with a government would also be constrained from deploying mass destruction weapons ([because of] aversion to risking the lives of very large numbers of people, excessive penalties, and loss of sympathy for the movement), it is difficult to discern any set of conditions short of sheer desperation which would ... lead terrorist groups to the conclusion that it was in their interest to employ a weapon of mass destruction."

- "Acts by terrorist groups ... have generally been performed by small groups. Participation by numbers in excess of 6 have been relatively rare, and by numbers in excess of 12 even rarer ... factors which tended in the past to keep criminal and terrorist groups small, principally fear of detection, would seem likely to continue."

- "It is a basic presumption ... that a conspiracy involving two or more cleared individuals is unlikely."

And also[4]

- "theft of multiple Category II quantities [e.g. less than 5 kg of highly enriched uranium] would be required to accumulate sufficient material to construct a nuclear explosive device, and the likelihood of a successful multiple theft [is] low."

It is hardly necessary to point out that the September 11 attacks serve as a direct counterexample to these assumptions, and consequently that the regulatory requirements that were imposed more than two decades ago are now obsolete. Of particular concern are the physical protection regulations for nonpower reactors (NPRs) that continue to possess and use highly enriched uranium (HEU) fuel. A historical review indicates that some members of the NRC staff and Commission had doubts about the adequacy of NRC's security rules for NPRs twenty years ago, yet most of the vulnerabilities they identified were never fixed.[5] More than a year after the September 11 attacks, NRC finally ordered security upgrades at some NPRs, but it has not amended its regulations to require NPRs to prevent the theft of HEU by a team of attackers or a conspiracy of insiders. Meanwhile, several U.S. university NPRs that have not converted to LEU fuel continue to store strategically significant quantities of lightly irradiated HEU under security conditions that are far less than optimal and may serve as tempting targets of opportunity for terrorists. This dangerous situation may be given new legitimacy and

perpetuated indefinitely if a proposed deal goes forward for the annual import of 250 kilograms of Russian HEU to supply some of the U.S. NPRs that have not yet converted.

Although this paper is focused on U.S. facilities and requirements, it contains observations that have international relevance. There are important similarities between NRC regulations and the current revision of INFCIRC/225. Also, the thresholds for material categories and spent fuel self-protection are almost identical in the two documents.

2. The Legacy of Lax Security Requirements for Nonpower Reactors

Regulatory requirements for physical protection at U.S. nonpower reactors are constrained by the stipulation of the Atomic Energy Act that the NRC can only impose the "minimum amount of regulation" to fulfill its obligations under the Act. This antiquated provision stems from an early desire to ensure that "the conduct of widespread and diverse research and development" would not be hamstrung by excessive regulation. However, the consequence of this restriction has been to place NPRs in a privileged class of their own without any technical justification. To this day, U.S. HEU-fueled NPRs remain exempt from most of the physical protection requirements that apply to other facilities possessing comparable quantities of special nuclear material.

In 1979, the NRC implemented the so-called "Physical Protection Upgrade Rule" for licensees possessing more than a formula quantity of special nuclear material (SNM), otherwise known as a Category I quantity (5 kg for HEU). This rule required that these licensees provide a "physical protection system ... designed to protect against the design basis threats of theft or diversion of strategic SNM and radiological sabotage ..." (10 CFR §73.20). The design basis threat (DBT) for theft of SNM (10 CFR §73.1(a)(2)), which is more severe than the DBT for radiological sabotage, includes an external attack by a small, well-trained, well-armed group, able to act in two or more teams, with the passive and/or active assistance of an insider.

To comply with these regulations, the licensee must develop an NRC-approved plan for a physical protection system with a five-person minimum Tactical Response Team as one component. The regulations explicitly require that the performance of the Tactical Response Team and security guards in responding to safeguards events be assessed through periodic force-on-force exercises, which must be open to NRC observation once a year (10 CFR §73.46(b)(9)). Other Category I requirements include strict access and exit controls, as well as access authorization procedures to deter insiders.

Facilities possessing between 1 and 5 kg of HEU, or Category II facilities, are required to provide less rigorous physical protection (10 CFR §73.67) than Category I facilities. Unlike Category I facilities, Category II facilities do not have to provide protection against the DBT described above. Thus Category II physical protection systems need not *prevent* unauthorized access and removal of SNM, but only have to *detect* removal of SNM and facilitate its location and recovery by "appropriate response forces," presumably local law enforcement. Category II facilities are not required to provide a tactical armed response capability or to conduct force-on-force exercises.

Another major difference between Category I and Category II security requirements is the treatment of the insider threat. Category II facilities are required to have a physical protection system that provides "early detection and assessment of unauthorized access or activities by an external adversary …" (10 CFR §73.67(a)(1)). Thus the early detection of unauthorized access or activities by *insiders* is not a required objective. This is in contrast to Category I facilities, for which the insider threat is an explicit component of the DBT.

The NRC's justification for a detection-based, rather than a prevention-based, strategy for theft of Category II quantities of SNM was grounded in two assumptions: first, that terrorists would have to carry out multiple attacks on Category II facilities to acquire enough SNM for a nuclear weapon, and second, that terrorist groups would not be capable of carrying out multiple simultaneous attacks. The only credible scenario in that case would be a series of sequential attacks, which could be defeated by a system that provided early warning of the first theft and triggered heightened protection at other facilities.

When NRC implemented the Upgrade Rule in 1979 for Category I facilities, NPR licensees were "temporarily" exempted pending completion of studies "intended to determine whether or not safeguards credit can be given to unique features associated with NPRs."[6] This exemption was ordered by NRC following receipt of public comment on the proposed rule expressing concerns about its potential impact on NPRs.[7] In fact, the official record clearly indicates that NRC feared that inclusion of NPRs under the upgrade rule would cause most of them to shut down.[8] While it is evident today that NPRs at university sites are more, rather than less, vulnerable than other licensee categories, this "temporary" exemption remains in effect, more than twenty years later.

Although NPRs possessing more than 5 kg of HEU were exempted from the stringent provisions of the Upgrade Rule, including requirements for a Tactical Response Team and periodic force-on-force performance testing, a set of "interim" measures was imposed at the time. These included all Category II requirements, plus a list of additional measures (10 CFR §73.60) that were designed "to give some protection against theft of material by an insider."[9] In particular, a requirement for continuous observation of all individuals within material access areas was added.

However, at the same time the rule exempted NPRs with Category I quantities of HEU from these additional requirements as long as less than 5 kg of HEU was unirradiated or had a radiation barrier below the "self-protection" criterion of 100 rem (1 Sv) per hour at one meter, unshielded. This loophole has allowed U.S. NPRs to store well over a bomb's worth of HEU on site under the minimal Category II security rules.

In 1984, NRC staff acknowledged that "coordinated theft attempts occurring simultaneously or within a short period of time could possibly defeat NRC's early detection strategy," and recommended a series of additional measures to upgrade security at Category II facilities. These included a requirement to reduce fresh HEU fuel holdings to a quantity as low as reasonably necessary; provide tamper-proof intrusion detection systems; impose a two-person rule and install access barriers over the core (for pool-type reactors where the fuel is accessible above the core). While the NRC ultimately did require NPRs to amend their licenses to minimize storage of fresh HEU, it took no action on the remaining recommendations.

Another important additional provision recommended by the NRC staff was a requirement that NPRs possessing more than 5 kg of HEU but satisfying the exemption criterion prepare Category I physical protection plans in the event that self-protection were lost and the exemption criterion could no longer be met. This proposal was also not adopted.

Subsequent efforts to strengthen physical protection at NPRs were overtaken by the NRC's decision to require conversion of most HEU-fueled NPRs to LEU, and most proposals for implementation of interim security upgrades pending NPR conversion and removal of all HEU fuel were never enacted. As a result, the remaining NRC-licensed NPRs that continue to use and store HEU fuel today need only satisfy Category II physical protection requirements that are inadequate in light of the post-September 11 terrorist threat.

However, the NRC has not taken swift action to rectify the disparity between the terrorist threat that its staff envisioned when the current regulations were developed and the known threat that is faced today. On June 21, 2002, the NRC sent a list of proposed security measures for research and test reactors with power levels above 2 MW to the reactor operators for comment.[10] After months of close consultation with NPR licensees, the NRC finally ordered additional physical protection measures to be applied at NPRs over 2 MW in late October 2002, nearly fourteen months after the September 11 attacks and several months after upgrades were ordered at Category I fuel cycle facilities.

Although the details of these security measures are considered safeguards information and are not publicly available, there is reason to believe that they do not go far enough in closing the security gaps at NPRs described earlier. First, since these measures have been issued only for the higher-power NPRs, they appear only to address radiological sabotage and not theft risks at facilities such as the 1 MW TRIGA reactors that have not yet converted. Second, the NRC is well aware that NPRs are in no better position today than they were twenty years ago to afford greater security, and that a requirement to provide Category I levels of physical protection would likely accelerate the pace of NPR shutdowns.

NRC's complacency with regard to NPR security is well-documented. For instance, consider the following responses to public comments expressing concerns about security that NRC received in reference to the application of the University of Missouri-Columbia Research Reactor (MURR) for an amendment to extend its operating license, dated October 29, 2001:

> "The results of recent NRC inspections found that the licensee is meeting the requirements of the physical security plan and the applicable regulations. The regulations do not require security drills or force-on-force tests for this class of licensee ... because the physical security plan meets the requirements of the regulations, the NRC has no basis to impose additional safeguards and surveillance requirements ... however, in light of the recent terrorist attacks ..., the NRC is reviewing its security regulations, and if any further actions are deemed appropriate, they will be implemented."

As noted earlier, it took another year for “further action” to be taken.

NRC's inability to adjust to present realities is clear in a February 19, 2002 letter to the State of Missouri Office of Homeland Security concerning security at MURR, in which NRC writes,[11]

> "Let me assure you that the provisions that protect the facility and fuel at the facility provide an acceptable level of protection. Research and test reactor licensees have safely maintained fuel at their facilities for many years."

In the post September-11 era, it is unconscionable for the NRC to allow NPRs to continue to store dangerous quantities of HEU without security measures capable of preventing unauthorized removal of SNM and fully protecting against the insider threat. These facilities should be required to protect against a design basis threat commensurate with that for other facilities possessing Category I quantities of SNM, and impose measures including armed responders, periodic force-on-force testing, and rigorous access authorization and access control procedures.

At the same time, the U.S. government must carry out an immediate reassessment of the assumptions underlying the current security regime for Category I materials, including the design basis threat characteristics and the size of a formula quantity, in view of the known magnitude and character of the September 11 threat.

Moreover, the U.S. government should only allow the export of HEU to foreign NPRs that have similar procedures and can demonstrate an operational capability to deter realistic threats. While INFCIRC/225 (Rev.4) recommends annual evaluations of the overall implemented physical protection system for both Category I and Category II facilities --- evaluations that "should also include exercises to test the training and readiness of guards and response forces" --- it does not specifically state that such evaluations should be integral force-on-force exercises.[12] However, anything short of force-on-force exercises cannot provide the level of confidence needed.

Even if the NRC's rules were changed to require protection at NPRs consistent with that at fuel cycle facilities, NRC would likely continue to argue that most of the HEU at US NPRs is secure because it is self-protecting under the 100 rem/hr criterion, so that these facilities should remain exempt from Category I requirements. For instance, NPRs today are licensed to possess well below 5 kg of unirradiated HEU. But it is also essential to reexamine the value of the current self-protection criterion in the context of the new terrorist threat.

3. Self-Protection: Psychological or Physical Deterrent?

Concerns have long been expressed about the adequacy of the 100 rem/hr "self-protection" criterion as a genuine deterrent to theft of SNM. A Los Alamos study in the early 1980s examined this question in some detail. The report stated that "the 100-rem/h value was apparently chosen as a deterrent with the idea that an adversary group would receive a sufficiently high dose that it would not be able to complete its mission of removing the fuel."[13]

However, the same report estimated that the total dose that an adversary would receive from the theft of a formula quantity of HEU contained in spent MTR fuel that just meets the self-protection threshold would be in the range of 50-100 rem, with the lower dose corresponding to a

theft time of about 5 hours and the higher to a theft time of about 2 hours (since in the latter case the thieves would take less care in protecting themselves). This dose is not nearly high enough to interfere with completion of the mission by incapacitating the participants. For that objective, the fuel would have to be able to maintain a dose rate on the order of 10,000 rem/hr, a rate unlikely to be achieved by any NPR spent fuel. This was recognized in 1982 by former NRC Commissioner Victor Gilinsky, who said that[14]

> "The 100 rem/hour is a meaningless number without technical justification. It is useless as a deterrent to any serious terrorist."

In 1984, the NRC announced its intention to carry out "a reexamination of the technical basis for the present irradiation exemption and whether irradiation provides a sufficiently effective inherent safeguards protection for formula quantities of SNM to justify the significantly lower level of physical protection associated with Category II."7[15] However, ultimately Commissioner Gilinsky's words were not heeded and the 100 rem/hr exemption remained.

Today, the NRC-licensed facilities that have not converted to LEU, yet continue to enjoy the self-protection exemption and authorization to maintain large quantities of HEU fuel on site include the MIT Research Reactor (MITR), the University of Missouri at Columbia (MURR) and the National Institute of Standards and Technology (NIST). Also included are several lifetime-core reactors that are scheduled to convert, but which in the meantime have in-core inventories of HEU exceeding 5 kg. These facilities are required to maintain only Category II physical protection, as long as the quantity of HEU that fails to meets the 100 rem/hr criterion is kept below 5 kg.

The physical protection landscape would look a lot different if the self-protection exemption were eliminated or the threshold were raised to an incapacitating dose level. In that case, nearly all remaining unconverted NPRs in the U.S. would have to significantly upgrade physical protection to Category I levels, because the core inventories of HEU in most cases exceed 5 kg. Although the dose rate from fuel at the higher power NPRs may significantly exceed the 100 rem/hr threshold, it is still unlikely to reach an incapacitating level --- even commercial spent fuel cannot maintain such a level for long after discharge.

How big is the problem today in the U.S.? Currently, the MITR license authorizes possession of 29 kg of HEU, which is more than one IAEA significant quantity and is enough for one to two unsophisticated implosion devices. While the license does not allow more than about 2 kg of that quantity to be unirradiated, there appears to be a considerable quantity of HEU (on the order of 10 kilograms) in partially burnt fuel that is still stored at the facility. And at 45 kg, the HEU possession limit at MURR is even greater than at MITR.

In an era of suicidal terrorists, one cannot credibly argue that a dose of at most a few hundred rem would serve any deterrent function at all from theft of materials that could be used to build a nuclear explosive. It is time for NRC to complete the reassessment of the 100 rem/hr criterion that it committed to in 1984 and choose a more appropriate value. If such an exercise would result in a requirement for significant security upgrades at the remaining U.S. NPRs with HEU fuel, then one potential solution to avoid facility shutdown would be for the U.S. to commit to

paying for interim security upgrades at these facilities in return for a renewed, iron-clad commitment to convert to LEU as soon as feasible --- which in view of the recent progress in high-density LEU fuels may be sooner rather than later.

4. The U.S.-Russia HEU Import Deal: A Step Backward

One potential obstacle to such an approach is the new threat to the RERTR program arising from a recent U.S.-Russia plan to import HEU from Russia for use as fuel in U.S. NPRs.[16] Ironically, the plan is part of a larger set of recommendations by a bilateral "experts group" intended to strengthen RERTR and other programs aimed at preventing the spread of nuclear weapons to terrorists and states. Several of the recommendations are admirable: accelerating and expanding the blend-down of Russian HEU into LEU; using this blended-down material to establish a strategic LEU reserve in the United States; and accelerating the RERTR program's development of LEU fuel for remaining HEU-fueled NPRs. However, one of the expert group's recommendations would undermine the RERTR program by proposing the "use of Russian HEU to fuel selected United States research reactors."

This provision would work against the longstanding RERTR goal of preventing Russia from becoming an alternative global supplier of HEU fuel. As has long been clear, if any state were to become such an alternative global supplier, it would undermine the U.S. supply leverage that has been an essential tool in achieving and sustaining the conversion of research reactors from HEU to LEU fuel. Indeed, on the two occasions where Russia has exported HEU to the West, it has blatantly undermined the aims of the RERTR program.

For example, in 1998 Russia agreed to supply HEU for the proposed German FRM-II research reactor at the Technical University-Munich in Garching. The United States had refused to supply HEU on grounds that the new reactor could and should be converted to LEU prior to start-up. As the U.S. State Department explained in 1994: "In accordance with U.S. Government policy, reinforced by the 1992 Energy Policy Act, the United States will not supply highly enriched uranium (HEU) for any new foreign research reactor, such as the Garching facility that may be built at the [Technical] University of Munich."[17] Without such a new supply of HEU, the FRM-II operator had access only to at most a five-year supply of HEU, which previously had been exported to Europe for a different German reactor (THTR) that closed prematurely. This means that the operator would have had to convert to lower enriched fuel after just five years, and in light of this fact, the operator might even have decided to convert to LEU prior to start-up. However, when Russia agreed to provide HEU, it removed the supply constraint, and the operator now has obtained and intends to use 93%-enriched HEU fuel for at least the first ten years of operation.[18]

Even when the FRM-II's HEU fuel is removed from the reactor, it will remain vulnerable to theft and diversion to weapons. Indeed, the spent fuel will still be 89%-enriched and will be permitted to cool for at least five years in a pond at the reactor site "until the fuel is practically cold . . . 60 watts per fuel element." At a projected 40 kg per year, this means that several hundred kilograms of 89%-enriched HEU eventually will accumulate in the cooling pond at this lightly guarded university site.[19] As NCI wrote in a letter to German Chancellor Gerhard Schroeder in

the wake of the September 11, 2001 terrorist attacks, the question is "whether the FRM-II at Garching can be defended against 19 well-armed, suicidal terrorists attacking from four different directions."[20]

Russia similarly agreed in 1996 to supply HEU to France for its two research reactors that had yet to convert to LEU. Although the French subsequently committed to convert the ILL-Grenoble reactor, they have not explored conversion of the Orphée reactor, which they intend to operate with HEU for the rest of its remaining life.[21] If it had not been for the Russian HEU supply, the French would have had to commit also to convert the Orphée reactor as soon as possible, in order to obtain HEU fuel for it from the United States in the interim prior to conversion.

Accordingly, in both cases, the emergence of Russia as an alternate HEU supplier undermined the RERTR program by perpetuating commerce in bomb-grade uranium longer than necessary. If Russia continues to act as such an alternate HEU supplier, it could further block progress in the RERTR program in three ways: enabling construction of new reactors that use HEU; permitting remaining HEU-fueled reactors to postpone conversion; and even facilitating the re-conversion back to HEU of some research reactors that previously have converted to LEU. To prevent this disastrous outcome, the RERTR program and all its supporters should oppose any further Russian exports of HEU that could weaken U.S. supply leverage.

If the United States imports HEU fuel from Russia for its own research reactors, it will have little moral standing to prevent others from doing likewise. In addition to the damage that this will cause to the RERTR program, the importation of HEU from Russia to the United States would directly increase proliferation and terrorism risks, despite the fact that the United States is already a nuclear-weapons state with its own domestic supplies of HEU. This is because transporting the Russian HEU domestically and then to the United States would raise more risks of theft and diversion than continuing to supply U.S. NPRs with domestic shipments of HEU. For both of these reasons, to sustain the impressive gains of the RERTR program and to minimize the direct terrorism risks, we strongly urge the U.S. to reject the proposed import of Russian HEU and to seek more productive incentives for Russian cooperation in the RERTR program.

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[3] U.S. Nuclear Regulatory Commission, "Safeguarding a Domestic Mixed Oxide Industry Against a Hypothetical Subnational Threat," NUREG-0414, May 1978.

[4] William Dircks, U.S. Nuclear Regulatory Commission, "Security Measures at Nonpower Reactors," SECY-84-216, May 25, 1884.

[5] The deficiencies in NRC's NPR security regulations were extensively analyzed in the 1980s by Daniel Hirsch, then director of the Stevenson Program on Nuclear Policy at the University of California, Santa Cruz. While the number of facilities using HEU is considerably smaller today, the criticisms of Mr. Hirsch from nearly two decades ago remain valid for the several remaining NPRs that still use HEU.

[6] U.S. Nuclear Regulatory Commission, "Nonpower Reactor Physical Protection Requirements," Generic Letter 80-038, May 7, 1980.

[7] William Dircks, U.S. Nuclear Regulatory Commission, "High Enriched Uranium at Nonpower Reactors," memorandum to the NRC Commissioners, January 25, 1984.

[8] D. Hirsch, "Resolving the Safeguards and Proliferation Risks Associated with Presence of Weapons-Grade Uranium at Research Reactors," report of the Adlai Stevenson Program on Nuclear Policy, University of California, Santa Cruz, June 17, 1985.
[9] William Dircks, January 25, 1984 memorandum, *op cit*.
[10] William D. Beckner, U.S. Nuclear Regulatory Commission, "Site-Specific Interim Compensatory Measures for Physical Security in the Current Threat Environment at Research and Test Reactors Licensed to Operate at Power Levels Greater Than or Equal to 2.0 Megawatts," letter to licensees, June 21, 2002; ADAMS accession number ML021440592.
[11] William D. Beckner, U.S. Nuclear Regulatory Commission, letter to Timothy Daniel, State of Missouri Office of Homeland Security, February 19, 2002; ADAMS accession number ML020430317.
[12] International Atomic Energy Agency, "The Physical Protection of Nuclear Material and Nuclear Facilities," INFCIRC/225 (Rev. 4), IAEA, Vienna, 1999.
[13] J.J. Koelling and E.W. Barts, "Special Nuclear Material Self-Protection Criteria Investigation," NUREG/CR-2492, LA-9213-MS, Los Alamos National Laboratory, January 1982.
[14] William Dircks, January 25, 1984 memorandum, *op cit*.
[15] Samuel Chilk, U.S. Nuclear Regulatory Commission, "Development of a Proposed Rule on the Use of HEU ans Steps to Improve Security Measures," memo to William Dircks, February 23, 1984.
[16] Joint Statement of Secretary Abraham and Minister Rumyantsev, September 16, 2002, http://www.energy.gov/HQPress/releases02/seppr/jointstatement.htm. The plan reportedly calls initially for the annual import of 250 kg of HEU for the MIT, MURR, ATR, HFIR and NIST reactors. See, Daniel Horner, "U.S. Refining Plan to Import HEU from Russia for U.S. Reactors," *Nuclear Fuel*, October 14, 2002.

[17] EUR (Voluntary) Press Guidance, May 10, 1994. The Schumer Amendment to the Energy Policy Act of 1992 bars HEU exports unless recipients satisfy three conditions: (1) they cannot yet convert to LEU; (2) they have committed to convert as soon as possible; and (3) there is an active development program to enable such conversion to LEU.

[18] Press Statement of Hans Zehetmair, Bavarian State Ministry for Science, Research and Art, Munich, October 25, 2001. Uschi Treffer, "Ein vertretbarer Kompromiss," *Sueddeutsche Zeitung*, October 26, 2001. Ann MacLachlan and Mark Hibbs, "SCK/CEN Asks U.S. to Stop Work on Export Until Status of its HEU Stocks is Resolved," *Nuclear Fuel*, November 12, 2001, says about the FRM-II that, "all the HEU needed for the first 10 years of operation [including the portion from Russia] is now in France, where fabricator Cerca is now manufacturing fuel elements for the reactor using the material." See also, "Germany: FRM-2 Reactor to be Converted to 'Medium' Enriched Uranium," *WISE NEWS*, Communique 557, November 2, 2001.

[19] Mark Hibbs, "FRM-2, BMU on Collision Course over Spent Fuel Management Issues," *Nuclear Fuel*, February 18, 2002.

[20] Letter from Alan J. Kuperman and Paul L. Leventhal to German Chancellor Gerhard Schroeder, October 29, 2001.

[21] Ann MacLachlan, "U.S. May Resume HEU Fuel Supply as France's ILL Studies Conversion," *Nuclear Fuel*, November 30, 1998, p. 3.